Numerical analysis of Wave-structure Interactions Using Potential-flow Solver

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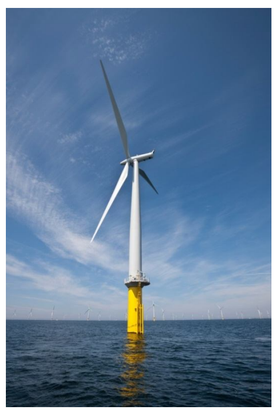
Introduction

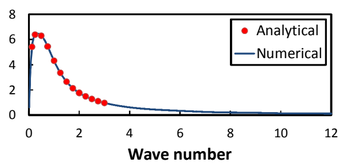
A potential-flow solver DIFFRACT* written in FORTRAN has been used to analyse the interactions between waves and 3D structures in frequency domain. The program is based on higher-order Boundary Element Method. Meshes generated by some commercial and free pre-processors (e.g. GAMBIT and SALOME) can be imported into the potential-flow solver to carry out hydrodynamic analysis.

Validation and Applications

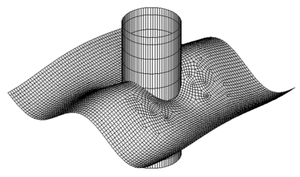
Single Fixed Structure



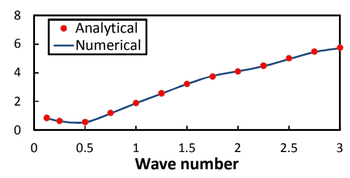
First-order wave force



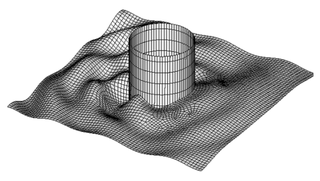
First-order surface elevations



Second-order wave force

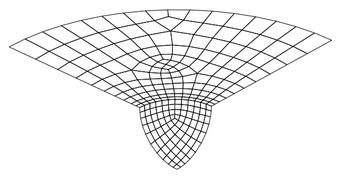


Second-order surface elevations



Numerical results of the first- and second-order forces on uniform cylinder have been validated by comparing with analytical solutions and good agreements have been obtained. Surface elevations around structure can also be predicted.

Single Floating Structure



Second-order horizontal force

Wave number	Kim and Yue	Present
1.2	1.067	1.102
1.6	0.778	0.811
2.0	0.829	0.860

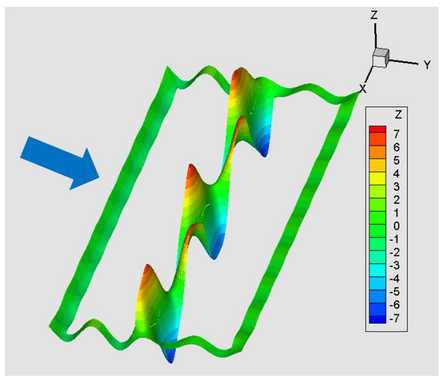
Second-order vertical force

Wave number	Kim and Yue	Present
1.2	2.338	2.335
1.6	1.383	1.388
2.0	1.918	1.917

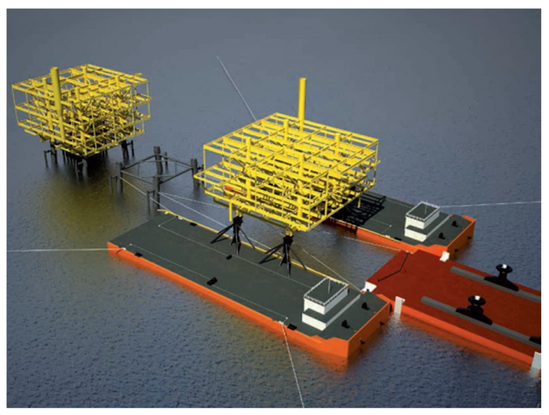
To predict the second-order forces on floating structure, the contribution from the first-order motions has to be considered. Satisfying agreements have been achieved in the comparisons with other published numerical results.

Multiple Floating Structures

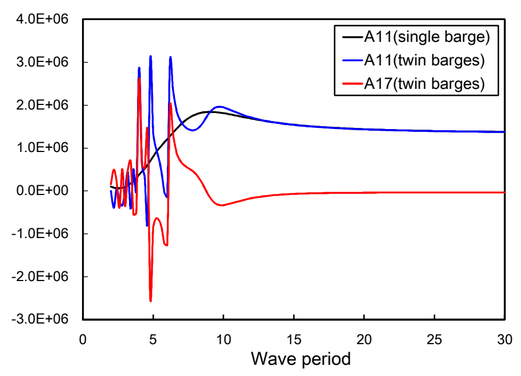
Violent surface behaviour in the gap



In the interactions between waves and multiple floating structures with small gap, violent local surface elevations have been found in the gap at some special frequencies, which are closely related to the peak values of wave forces and motions of floating structures.

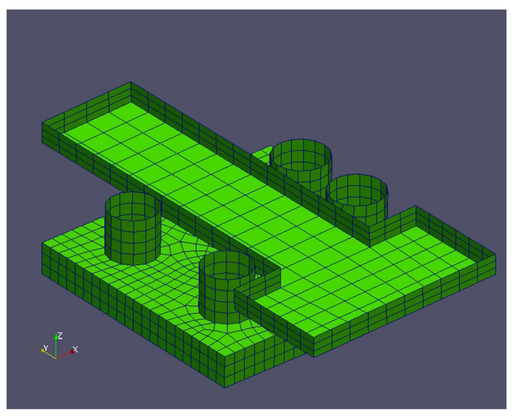


Hydrodynamic coefficient



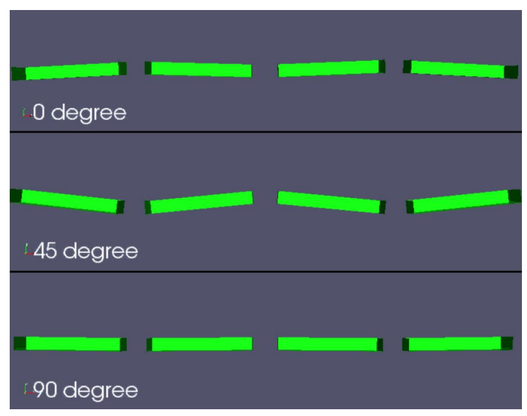
Hydrodynamic characteristics (including hydrodynamic coefficients and wave excitation forces) of multiple floating bodies may change dramatically comparing with those of single structure.

Multiple Fixed/Floating Structures



Large dimensional substructures have significant effects on the motions of installation barge during float-over installation.

Interconnected Floating Structures



Both hydrodynamic interactions and mechanical connections in interconnected multiple floating structures can be considered in a two-stage approach which offers great flexibility for systems that have complex constraints or where the linking components require optimization.

Concluding Remarks

- Numerical results from potential-flow solver DIFFRACT* have been validated by comparing with analytical solutions and other published results
- Hydrodynamic/dynamic interactions have to be considered to provide accurate predictions in the interactions between waves and multiple structures
- Extensive wave-structure interactions in offshore engineering can be investigated using present potential-flow solver DIFFRACT*

* http://www.mendeley.com/groups/2020743/4diffract/papers/